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## Unravelling Sources of Variation in Large-Scale Food Production with Power Spectral Density Analysis

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Quality testing in the food industry is usually performed by manual sampling and at/offline laboratory analysis, which is labor intensive, time consuming, and may suffer from sampling bias. For many quality attributes such as fat, water and protein, in-line near-infrared spectroscopy (NIRS) is an alternative to grab sampling and which provides richer information about the process.

In this ENBIS abstract, we present benefits of in-line measurements at the industrial scale. Specifically, we demonstrate the advantages of in-line NIRS, including improved precision of batch estimates and enhanced process understanding, through the analysis of power spectral density (PSD) which served as a diagnostic tool. With the PSD it was possible to attribute and quantify likely sources of variations.

The results are based on a case regarding the large-scale production of Gouda-type cheese, where in-line NIRS was implemented to replace traditional laboratory measurements. In conclusion, the PSD of in-line NIRS predictions revealed unknown sources of variation in the process that could not have been discovered using grab sampling. Moreover, the dairy industry benefited from more reliable data on key quality attributes, providing a strong foundation for future improvements.

While our study focused on a single industrial case, the advantages of in-line NIRS and the application of PSD analysis are expected to have broader applicability in the food industry.

[1] Solberg, L.E. *et al.*. In-Line Near-Infrared Spectroscopy Gives Rapid and Precise Assessment of Product Quality and Reveals Unknown Sources of Variation—A Case Study from Commercial Cheese Production. *Foods* 2023.

### Keywords

process diagnostics, in-line monitoring, power spectra density

### Classification

Mainly application

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